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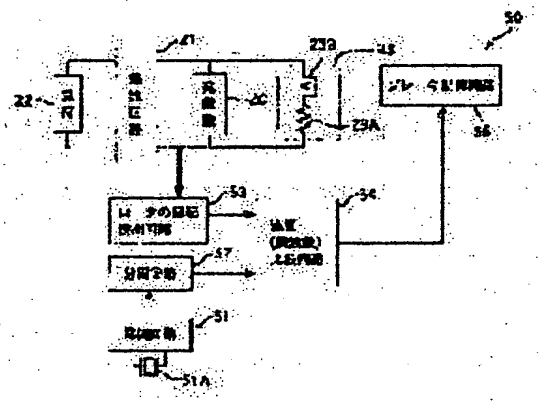
(54) ELECTRONICALLY CONTROLLED MECHANICAL TIMEPIECE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an electronically controlled mechanical timepiece which can quickly respond to speed governing control and can be reduced in cost.
SOLUTION: An electronically controlled mechanical timepiece is provided with a generator 20 which converts the mechanical energy transmitted from a spiral spring through a train wheel into electrical energy and a rotation control means 50 which is driven with the converted electrical energy to control the rotational period of the generator 20. The control means 50 is provided with a speed comparator circuit 54 which compares a rotation detecting signal from a rotation detecting circuit 53 with a reference signal from a frequency dividing circuit 52 at every period of the rotational waveform of a rotor and a brake control circuit 56 which controls a brake so that the brake may be applied to the rotor when the comparator circuit 54 judges that the period of the rotation detecting signal is shorter than that of the reference signal and may not be applied to the rotor when the circuit 54 judges that the period of the rotation detecting signal is longer than that of the reference signal.



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CLAIMS

[Claim(s)]

[Claim 1] An electronics control type machine clock equipped with a generator which changes into electrical energy mechanical energy of a spiral spring and a spiral spring transmitted through **** characterized by providing the following, an indicator combined with said ****, and a roll control means to drive with said changed electrical energy and to control a rotation period of said generator Said roll control means is an oscillator circuit which makes a reference signal used as a time amount standard of a clock. A rotation detector which detects rotation of Rota of said generator A speed comparator circuit which measures a reference signal output of said oscillator circuit, and a rotation detecting-signal output of said rotation detector for every period of a rotational wave form of Rota A brake control circuit controlled in this speed comparator circuit to add a brake to a period of the following one period of Rota, and Rota, and not to add a brake to a period of the following one period of Rota, and Rota when a period of a rotation detecting signal is longer than a period of a reference signal when a period of said rotation detecting signal is shorter than a period of said reference signal

[Claim 2] It is the electronics-control type machine clock which is comparing signal-level change timing after fixed time amount with output timing of the next rotation detecting signal of said rotation detecting signal from said rotation detecting signal of a reference signal output outputted according to a rotation detecting signal to which said speed comparator circuit's is outputted from said rotation detector in an electronics-control type machine clock according to claim 1, and is characterized by to compare a period of a rotation detecting signal with a period of a reference signal.

[Claim 3] It is the electronics control type machine clock characterized by performing chopper brake control in case said brake control circuit adds a brake to Rota in an electronics control type machine clock according to claim 1 or 2.

[Claim 4] While said rotation detecting signal and reference signal are equipped with an updown counter inputted into a rise count input and a down count input, respectively in an electronics control type machine clock according to claim 1 to 3 When a cumulative error detection output outputted according to a counter value is an ON state, this updown counter An electronics control type machine clock characterized by being constituted so that the progress / delay output which has priority over an output of said brake control circuit, and controls a brake may be outputted according to a counter value.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention relates to the electronics control type machine clock which drives correctly the indicator fixed to **** by changing mechanical energy in case a spiral spring opens into electrical energy with a generator, operating a roll control means with the electrical energy, and controlling the rotation period of a generator.

[0002]

[Background of the Invention] What was indicated by JP,7-119812,B and JP,8-50186,A is known as an electronics control type machine clock which drives correctly the indicator fixed to **** and displays time of day correctly by controlling the current value which mechanical energy in case a spiral spring opens is changed into electrical energy with a generator, and a roll control means is operated with the electrical energy, and flows in the coil of a generator.

[0003] What was indicated by JP,7-119812,B preparing the angle range which turns off a brake, raises the rotational speed of Rota for every period of a reference signal, and increases the amount of generations of electrical energy, and the angle range which applies brakes and is turned at a low speed, and raising generated output in between where said rotational speed is high, while Rota rotated one time that is, as the fall of the generated output at the time of a brake was compensated, it was governing it.

[0004] Moreover, what was indicated by JP,8-50186,A counted the reference pulse and the measurement pulse detected with rotation of Rota, and compared the number of reference pulses with the number of measurement pulses, in the 1st condition that the number of reference pulses is smaller than the number of measurement pulses, generated the brake signal with which said measurement pulse was answered by the

control means, and pulse width was set up, and was performing brake control.
[0005]
[Problem(s) to be Solved by the Invention] However, since ON control and OFF control of a brake were surely performed for every reference signal while Rota rotates one time that is, the amount of roll controls of Rota for every reference signal was not made so greatly, but by the time it shifted to the normal control state, it required time amount, and some which were indicated to JP,7-119812,B had the problem that responsibility was low, when the time of the standup of a generator etc. and control separated greatly especially.
[0006] Moreover, since the pulse width of the brake signal generated for every reference signal was fixed, by the time it shifted to the normal control state, time amount was taken, and some which were indicated to JP,8-50186,A had the same problem that responsibility was low, since the amount of brakes for every reference signal was fixed, when control separated greatly.
[0007] Moreover, the control means which generates the brake signal with which the measurement pulse other than the circuit which detects the 1st and 2nd condition was answered, and pulse width was set up by the count and comparison of a reference pulse and a measurement pulse needed to be established separately, the configuration became complicated and there was also a problem that cost was high.
[0008] The purpose of this invention has the quick responsibility of governing control, and it is to offer the electronics control type machine clock which can also reduce cost.
[0009]
[Means for Solving the Problem] A generator from which an electronics control type machine clock of this invention changes into electrical energy mechanical energy of a spiral spring and a spiral spring transmitted through ****, In an electronics control type machine clock equipped with an indicator combined with said ****, and a roll control means to drive with said changed electrical energy and to control a rotation period of said generator An oscillator circuit which makes a reference signal with which said roll control means serves as a time amount standard of a clock using a quartz resonator etc., A speed comparator circuit which measures a rotation detector which detects rotation of Rota of said generator, and a reference signal output of said oscillator circuit and a rotation detecting-signal output of said rotation detector for every period of a rotational wave form of Rota, In this speed comparator circuit when a period of said rotation detecting signal is shorter than a period of said reference signal It is characterized by having a brake control circuit controlled to add a brake to a period of the following one period of Rota, and Rota, and not to add a brake to a period of the

following one period of Rota, and Rota when a period of a rotation detecting signal is longer than a period of a reference signal.

[0010] An electronics control type machine clock of this invention drives an indicator and a generator by spiral spring, and governs a rotational frequency of Rota, i.e., ******, by applying brakes to a generator with a braking means of a roll control means.

[0011] A roll control means of a generator under the present circumstances, a reference signal output from an oscillator circuit, and a rotation detecting signal output from a rotation detector In a speed comparator circuit, it compares for every period of a rotational wave form of Rota. By the comparison result a brake control circuit When a period of a rotation detecting signal is shorter than a period of said reference signal (i.e., when rotational speed of Rota is quicker than a reference signal output) A brake is added to a period of the following one period of Rota, and Rota, and when a period of a rotation detecting signal is longer than a period of a reference signal (i.e., when rotational speed of Rota is slower than said reference signal output), it controls not to add a brake to a period of the following one period of Rota, and Rota.

[0012] For this reason, since brakes will continue being applied until rotational speed becomes slower than a reference signal output, when torque of sources of mechanical energy, such as a spiral spring, is large, rotation of a generator is progressing for example, and a condition that rotational speed of Rota is quicker than a reference signal output continues, it can govern to a quickly normal rotational speed, and quick control of responsibility can be performed.

[0013] Moreover, a period of a rotation detecting signal of Rota is shorter than a period of a reference signal, or it is long, or since a chisel was detected and brake control is set up, a configuration of a roll control means is simplified and cost can also be reduced.

[0014] Under the present circumstances, said speed comparison means is comparing signal level change timing after fixed time amount with output timing of the next rotation detecting signal of said rotation detecting signal from said rotation detecting signal of a reference signal output outputted according to a rotation detecting signal outputted from said rotation detector, and it is desirable to compare a period of a rotation detecting signal of Rota with a period of a reference signal.

[0015] Whenever it makes it output a reference signal output according to a rotation detecting signal, fixed timing can compare a next rotation detecting signal and a next reference signal output. For this reason, a comparison with a rotation detecting signal and a reference signal output can always be performed on exact and fixed criteria, also in the condition of Rota immediately after starting of a generator being stabilized and not rotating especially, a rotation condition of Rota can be grasped certainly and

correctly, and suitable brake control can be performed.

[0016] Furthermore, in case said brake control circuit adds a brake to Rota, it may perform chopper brake control. If chopper brake control is performed, there is an advantage which can increase braking torque maintaining generated output more than fixed.

[0017] Moreover, while the electronics-control type machine clock of this invention is further equipped with the updown counter as which said rotation detecting signal and reference signal are inputted into a rise count input and a down count input, respectively, this updown counter may be constituted so that the progress / the delay output which has priority over an output of said brake control circuit, and controls a brake may output according to a counter value, when the cumulative error detection output outputted according to a counter value is an ON state.

[0018] Like [when an impact joins the time of starting of a generator, and a clock], since brake control can be performed so that a cumulative error may be counted and the error may be abolished if it has such an updown counter, when rotation of Rota shifts greatly, the gap can be lost and it can return to a quickly normal control state.

[0019]

[Embodiment of the Invention] Below, the operation gestalt of this invention is explained based on a drawing.

[0020] Drawing 1 is the plan showing the important section of the electronics control type machine clock of the 1st operation gestalt of this invention, and drawing 2 and drawing 3 are the cross section.

[0021] The electronics control type machine clock is equipped with the barrel vehicle 1 which consists of spiral spring 1a, barrel gear 1b, barrel truth 1c, and 1d of barrel lids. As for spiral spring 1a, barrel gear 1b and an inner edge are fixed to barrel truth 1c for an outer edge. Barrel truth 1c is supported by a cope plate 2 and ****** 3, and it is being fixed with the angle hole screw 5 so that it may rotate by the angle hole vehicle 4 and one.

[0022] Although the angle hole vehicle 4 is rotated clockwise, ** has geared with ** 6 so that it may not rotate counterclockwise. In addition, since the method of rotating the angle hole vehicle 4 clockwise and rolling spiral spring 1a is the same as that of the automatic volume of a machine clock, or a **** device, explanation is omitted. It accelerates rotation of barrel gear 1b 7 times, and accelerates 6.4 times one by one to the No. 2 vehicle 7. To the No. 3 vehicle 8 9.375 It double-accelerates, and to the No. 4 vehicle 9, it accelerates 3 times, and it accelerates 10 times to the No. 5 vehicle 10, and a total of 126,000 times accelerates to the No. 6 vehicle 11 through each **** 7-11 which it

accelerates 10 times and serves as accelerating **** to Rota 12.

[0023] The second hand 14 to which the minute hand 13 to which cylinder kana 7a performs a time stamp to cylinder kana 7a performs a time stamp in the No. 4 vehicle 9 is being fixed to the No. 2 vehicle 7, respectively. Therefore, what is necessary is just to control Rota 12 to rotate by 5rps, in order to rotate the No. 2 vehicle 7 by 1rph and to rotate the No. 4 vehicle 9 by 1rpm. Barrel gear 1b at this time is set to 1/7rph.

[0024] This electronics control type machine clock is equipped with Rota 12, the stator 15, and the generator 20 that consists of coil blocks 16. Rota 12 consists of Rota magnet 12a, Rota kana 12b, and Rota circle-of-inertia board 12c. Rota circle-of-inertia board 12c is for lessening rotational frequency fluctuation of Rota 12 to the driving torque fluctuation from the barrel vehicle 1. A stator 15 carries out the coil of the stator-coil 15b of 40,000 turns to stator object 15a.

[0025] The coil block 16 carries out the coil of the coil 16b of 110,000 turns to core 16a. Here, stator object 15a and core 16a consist of PC permalloys etc. Moreover, stator-coil 15b and coil 16b are connected to the serial so that the output voltage which applied each generation-of-electrical-energy voltage may come out.

[0026] Next, the control circuit of an electronics control type machine clock is explained with reference to drawing 4 and 5.

[0027] The block diagram showing the electronics control type machine clock of this operation gestalt is shown in drawing 4 , and the circuit diagram is shown in drawing 5 .

[0028] the rectifier circuit 21 where the ac output from a generator 20 consists of pressure-up rectification, full wave rectification, half-wave rectification, transistor rectification, etc. -- letting it pass -- a pressure up -- it is rectified. The loads 22, such as ICs for control, such as a roll control means, and a quartz resonator, are connected to the rectifier circuit 21. In addition, drawing 4 has indicated independently [a load 22] each functional circuit of explanation constituted in IC for convenience.

[0029] The brake circuit 23 from which it connected with the serial and transistor 23B of damping resistance 23A and Nch, or Pch was constituted by the generator 20 is connected to juxtaposition. The roll control means 50 is connected to the brake circuit 23. In addition, the diode other than damping resistance 23A may be suitably inserted in a brake circuit 23.

[0030] The roll control means 50 is constituted by an oscillator circuit 51, the frequency divider 52, the rotation detector 53, the speed (frequency) comparator circuit 54, and the brake control circuit 56.

[0031] An oscillator circuit 51 outputs an oscillation signal using quartz-resonator 51A, and dividing of this oscillation signal is carried out by the frequency divider 52 to a

certain fixed period. With this operation gestalt, as shown in drawing 5 , it has two frequency dividers 52A and 52B. In addition, a reference signal may be created using various kinds of criteria standard sources of vibration etc. instead of quartz-resonator 51A.

[0032] Frequency divider 52A outputs the 16kHz pulse signal for making the reset pulse mentioned later. Frequency divider 52B outputs a 10Hz reference clock (reference signal) to the speed comparator circuit 54.

[0033] It has four flip-flops 61-64, and the inverter (reversal) gates 65 and 66 and the AND gates 67, and the speed comparator circuit 54 is constituted, as shown in drawing 5 .

[0034] Flip-flops 61 and 62, the inverter gate 65, and the AND gate 67 are used in order to create the counter reset pulse 70 in the timing chart of drawing 6 , and they are constituted so that the counter reset pulse 70 may be outputted corresponding to the standup of a motor pulse (rotation detecting signal). In addition, each flip-flops 61-64 are constituted so that data may be outputted to outputs 1Q-4Q at the time of falling of a clock.

[0035] The flip-flop 63 is constituted so that the reference clock from frequency divider 52B which is reset by said counter reset pulse 70 and is similarly reset by the reset pulse 70 may be received by the clocked into. And in this circuit, since ground level is set as H level, according to the time of falling of a reference clock, H level signal is outputted from output 3Q (refer to the timing chart of drawing 6). Therefore, if the following motor pulse will be inputted by the time of falling change of a reference clock and a reset pulse 70 is outputted, output 3Q will not change with L level signal (refer to 2 period eye from the left of drawing 6).

[0036] The flip-flop 64 into which output 3Q is inputted Since a brake control pulse is outputted and the motor pulse is inputted into the clocked into through the inverter gate 66, As for the following period to which, as for the following period to which H level signal was outputted from output 3Q, the signal (brake control OFF) of H level was outputted from output 4Q, and L level signal was outputted from output 3Q, L level signal (brake control ON) is outputted.

[0037] Output 4Q of this flip-flop 64 is outputted to the gate of transistor 23B of Pch as it is. Therefore, if L level signal is outputted from this output 4Q, it will be maintained by ON condition, a generator 20 will short-circuit, and transistor 23B will require a brake.

[0038] On the other hand, if H level signal is outputted from output 4Q, in order that the gate voltage of transistor 23B may go up, transistor 23B is maintained by the OFF

condition and a brake does not join a generator 20. Therefore, this speed comparator circuit 54 is also making the brake control circuit 56 serve a double purpose.

[0039] Next, the actuation in this operation gestalt is explained also with reference to the timing chart of drawing 6 .

[0040] If a generator 20 begins to operate and a motor pulse (rotation detecting signal) is detected in the rotation detector 53, each flip-flop 61 and the reset pulse 70 which synchronized with the motor pulse in 62 grades will be generated first.

[0041] And frequency divider 52B reset by this reset pulse 70 outputs the reference clock (10Hz) on the basis of a reset pulse 70 to a flip-flop 63. Therefore, a flip-flop 63 generates the signal which starts from a reset pulse 70 after fixed time amount (this operation gestalt 100msec(s)) progress in output 3Q. However, since a flip-flop 63 is also reset when the following motor pulse is inputted and a reset pulse 70 is generated before fixed time amount progress (i.e., when the standup timing of the following motor pulse is earlier than the falling timing of a reference clock), output 3Q is maintained with the condition of L level.

[0042] And output 4Q of a flip-flop 64 When H level signal is outputted from 3Q (i.e., when the standup timing of the following motor pulse is later than the falling timing of a reference clock) The signal (H level signal) which turns off the period of one period of the following motor pulse and a brake is outputted. On the contrary, when L level signal is outputted from 3Q (i.e., when the standup timing of the following motor pulse is earlier than the falling timing of a reference clock), the signal (L level signal) which turns on the period of one period of the following motor pulse and a brake is outputted.

[0043] Thereby, when a period is [a motor pulse] short, that is, the rotational speed of a generator 20 is high compared with a reference clock, since the brake circuit 23 of a generator 20 is turned on, a brake is added, and the brake circuit 23 of a generator 20 is turned off by reverse when [that the period of a motor pulse is long that is,] the rotational speed of a generator 20 is low, and a brake is taken off compared with a reference clock, governing of a generator 20 is performed.

[0044] in addition -- although the reference signal of frequency divider 52B has a time lag between the standup timing of a motor pulse since it is generated according to the timing of falling of the counter reset pulse 70 -- this gap -- the case of this operation gestalt -- max -- about 61microsec it is -- while it is very small, since most gap time amount is regularity, in case it compares each motor pulse with a reference signal, that effect can also abolish it.

[0045] According to such this operation gestalt, there are the following effects.

[0046] ** Compare the rotation detecting signal (motor pulse) of Rota 12 with a

reference signal (reference clock). Since very simple control of detecting whether the period of a rotation detecting signal being short or long compared with the period of a reference signal, applying the period brakes of the following one period of Rota 12 in being short, and not applying brakes in being long is performed Circuitry can be simplified, components cost and a manufacturing cost can be reduced, and an electronics control type machine clock can be offered cheaply.

[0047] ** If the condition that the period of a rotation detecting signal is short continues compared with the period of a reference signal since brake control is performed for every period of Rota 12 for example, even when it can continue applying brakes and the rotation periods at the time of the standup of a generator 20 etc. are shifted more greatly than a criteria period, it can bring close to criteria speed quickly, and responsibility of governing control can be made quick.

[0048] ** Since it is reset by the reset pulse 70 based on a motor pulse, frequency divider 52B can synchronize a motor pulse and a reference signal, since the reference signal compared with a motor pulse can always be done to a fixed period from a reset pulse 70, can always judge correctly the progress/delay over the reference signal of a motor pulse, and can perform brake control.

[0049] Since the period of a motor pulse is not fixed especially immediately after starting of a generator 20, either, there is a possibility that a phase with a reference signal may shift and an exact comparison may become impossible, but since a reference signal is reset and it is made to synchronize with a motor pulse by the reset pulse 70 for every period of a motor pulse with this operation gestalt, also immediately after starting of a generator 20, exact brake control can be performed and the stability of a system can also be secured.

[0050] ** Although the generating period of a motor pulse has velocity turbulence in the short term since each period of a motor pulse is always compared with a reference signal and you are making it reflected in brake control of the motor pulse just behind that, continuing changing over long duration can be prevented. For this reason, there is no wandering of movement which is the degree which people can recognize by speed change of a generator 20 at the time of movement of an electronics control type machine clock, and though it is a simple configuration, it can offer the electronics control type machine clock which is satisfactory practically.

[0051] Next, the 2nd operation gestalt of this invention is explained with reference to drawing 7 and 8. in addition, this operation gestalt -- setting -- the component the same as that of the above-mentioned 1st operation gestalt, or same -- the same sign -- giving -- explanation -- an abbreviation -- or it carries out simple.

[0052] As this operation gestalt is shown in drawing 7 , only the point of having formed the chopper ring circuit 80 which consists of NAND gate 83 where the output of the inverter gate 81, the chopper pulse generating circuit 82 of several several 10Hz - kHz (for example, 10Hz - 10kHz) degree, the inverter gate 81, and the chopper pulse generating circuit 82 is inputted into output 4Q of a flip-flop 64 is different from said 1st operation gestalt.

[0053] With this operation gestalt of this, if L level signal which turns on a brake circuit 23 from a flip-flop 64 is outputted as shown in the timing chart of drawing 8 , a generator 20 will also be controlled by becoming a chopper brake control output and transistor 23B being turned on and off by the chopper ring circuit 80 with this output by the chopper brake.

[0054] Also in such this operation gestalt, when the same effect as ** of said 1st operation gestalt - ** is acquired, there is an effect which can increase braking torque, maintaining generated output more than fixed, since ** chopper ring control is performed. That is, by turning on and off and carrying out the chopper ring of the transistor 23B which can short-circuit the coil both ends of a generator 20, when transistor 23B is turned on, short brakes are applied to a generator 20, and the coil of a generator 20 is covered with energy. On the other hand, if transistor 23B is turned off, a generator 20 operates, and since a part for the energy with which said coil was covered is contained, an electromotive voltage will increase. For this reason, if a generator 20 is controlled by the chopper ring, the fall of the generated output at the time of a brake can be filled up by part for the rise of the electromotive voltage at the time of switch-off, damping torque can be increased, maintaining generated output more than fixed, and the long electronics control type machine clock of the persistence time can be constituted.

[0055] Next, the 3rd operation gestalt of this invention is explained with reference to drawing 9 and 10. in addition, this operation gestalt -- setting -- the component the same as that of the above-mentioned 1st operation gestalt, or same -- the same sign -- giving -- explanation -- an abbreviation -- or it carries out simple.

[0056] This operation gestalt is equipped with the updown counter 92 by which the motor pulse was considered as the rise count input, and the output (reference signal: 10Hz) of the frequency divider 91 which is not reset was considered as the down count input as shown in drawing 9 . The cumulative error of the motor pulse over a reference signal is counted by carrying out counting of the motor pulse from the time of starting of a generator 20, and the output of a frequency divider 91, and measuring them by this updown counter 92.

[0057] When a cumulative error becomes large when H level signal is usually outputted to this updown counter 92 and said counter value crosses a fixed range that is, the cumulative error detection output which outputs L level signal, and the progress / delay output which outputs the signal (H level signal) which will output the signal (L level signal) which turns on a brake if said cumulative error is the direction of motor pulse advance, and turns off a brake if it is the direction of delay are prepared. In addition, as for progress / delay output, the cumulative error detection output is maintained at L level at the period of H level.

[0058] Said cumulative error detection output is inputted into the AND gate 93 with output 4Q of a flip-flop 64, and the output of this AND gate 93 is inputted into the OR gate 94 with said progress / delay output.

[0059] With such this operation gestalt, a motor pulse and the reference signal of a frequency divider 91 count by the updown counter 92 to starting of a generator 20 and coincidence. When the difference of the enumerated data of a motor pulse and the enumerated data of a reference signal has fallen [the counted value of an updown counter 92] within the fixed range in the set point that is, based on output 4Q of a flip-flop 64, brake control is performed like said 1st operation gestalt.

[0060] If the generator 20 is rotating quickly, the enumerated data of a motor pulse become larger than the enumerated data of a reference signal on the other hand and the difference becomes beyond the set point, a cumulative error detection output will serve as L level. For this reason, a mask is applied to output 4Q of a flip-flop 64, the output of the AND gate 93 is always set to L level, and output 4Q is canceled.

[0061] For this reason, the signal of progress / delay output is outputted to a brake circuit 23, and a brake is controlled so that this abolishes a cumulative error. That is, when the enumerated data of a motor pulse are larger than the enumerated data of a reference signal, L level signal is outputted, a brake is turned on compulsorily, when the enumerated data of a motor pulse are smaller than the enumerated data of a reference signal, H level signal is outputted and a brake is turned off compulsorily.

[0062] According to such this operation gestalt, when the same effect as ** of said 1st operation gestalt · ** is acquired, there is the following effect.

[0063] ** Since the updown counter 92 is formed, when the cumulative error of the motor pulse advance / delay over a reference signal can be counted and a cumulative error becomes large beyond the set point, brake control can be performed so that that cumulative error may be abolished, for this reason, when the cumulative error has arisen, it can return to normal control quickly, and the responsibility of governing control can be raised further.

[0064] In addition, this invention is not limited to said each operation gestalt, and the deformation in the range which can attain the purpose of this invention, amelioration, etc. are included in this invention.

[0065] For example, the chopper ring circuit 80 of the 2nd operation gestalt is established in the output side of the OR gate 94, and you may enable it to perform chopper ring control also in the 3rd operation gestalt in said 3rd operation gestalt.

[0066] Moreover, what is necessary is just to set up suitably the concrete configuration of the speed comparator circuit 54 or the brake control circuit 56 not only according to said each operation gestalt but according to the configuration of the brake circuits 23 when transistor 23B of Nch is used etc. Moreover, what is necessary is just to set up suitably the output of frequency divider 52A which the counter reset pulse 70 generates not only according to a 16kHz pulse signal but according to the rotation period of Rota 12 etc.

[0067] Furthermore, what is necessary is just to set up suitably the means which compares the period of the rotation detecting signal of Rota, and a reference signal not only according to the thing of each of said operation gestalt but according to a configuration.

[0068]

[Effect of the Invention] As stated above, according to the electronics control type machine clock of this invention, the responsibility of governing control is quick and can also reduce cost.

TECHNICAL FIELD

[The technical field to which invention belongs] This invention relates to the electronics control type machine clock which drives correctly the indicator fixed to **** by changing mechanical energy in case a spiral spring opens into electrical energy with a generator, operating a roll control means with the electrical energy, and controlling the rotation period of a generator.

PRIOR ART

[Background of the Invention] What was indicated by JP,7-119812,B and JP,8-50186,A is known as an electronics control type machine clock which drives correctly the indicator fixed to **** and displays time of day correctly by controlling the current value

which mechanical energy in case a spiral spring opens is changed into electrical energy with a generator, and a roll control means is operated with the electrical energy, and flows in the coil of a generator.

[0003] What was indicated by JP,7-119812,B preparing the angle range which turns off a brake, raises the rotational speed of Rota for every period of a reference signal, and increases the amount of generations of electrical energy, and the angle range which applies brakes and is turned at a low speed, and raising generated output in between where said rotational speed is high, while Rota rotated one time that is, as the fall of the generated output at the time of a brake was compensated, it was governing it.

[0004] Moreover, what was indicated by JP,8-50186,A counted the reference pulse and the measurement pulse detected with rotation of Rota, and compared the number of reference pulses with the number of measurement pulses, in the 1st condition that the number of reference pulses is smaller than the number of measurement pulses, generated the brake signal with which said measurement pulse was answered by the control means, and pulse width was set up, and was performing brake control.

EFFECT OF THE INVENTION

[Effect of the Invention] As stated above, according to the electronics control type machine clock of this invention, the responsibility of governing control is quick and can also reduce cost.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, since ON control and OFF control of a brake were surely performed for every reference signal while Rota rotates one time that is, the amount of roll controls of Rota for every reference signal was not made so greatly, but by the time it shifted to the normal control state, it required time amount, and some which were indicated to JP,7-119812,B had the problem that responsibility was low, when the time of the standup of a generator etc. and control separated greatly especially.

[0006] Moreover, since the pulse width of the brake signal generated for every reference signal was fixed, by the time it shifted to the normal control state, time amount was taken, and some which were indicated to JP,8-50186,A had the same problem that responsibility was low, since the amount of brakes for every reference signal was fixed,

when control separated greatly.

[0007] Moreover, the control means which generates the brake signal with which the measurement pulse other than the circuit which detects the 1st and 2nd condition was answered, and pulse width was set up by the count and comparison of a reference pulse and a measurement pulse needed to be established separately, the configuration became complicated and there was also a problem that cost was high.

[0008] The purpose of this invention has the quick responsibility of governing control, and it is to offer the electronics control type machine clock which can also reduce cost.

MEANS

[Means for Solving the Problem] A generator from which an electronics control type machine clock of this invention changes into electrical energy mechanical energy of a spiral spring and a spiral spring transmitted through ****, In an electronics control type machine clock equipped with an indicator combined with said ****, and a roll control means to drive with said changed electrical energy and to control a rotation period of said generator An oscillator circuit which makes a reference signal with which said roll control means serves as a time amount standard of a clock using a quartz resonator etc., A speed comparator circuit which measures a rotation detector which detects rotation of Rota of said generator, and a reference signal output of said oscillator circuit and a rotation detecting-signal output of said rotation detector for every period of a rotational wave form of Rota, In this speed comparator circuit when a period of said rotation detecting signal is shorter than a period of said reference signal It is characterized by having a brake control circuit controlled to add a brake to a period of the following one period of Rota, and Rota, and not to add a brake to a period of the following one period of Rota, and Rota when a period of a rotation detecting signal is longer than a period of a reference signal.

[0010] An electronics control type machine clock of this invention drives an indicator and a generator by spiral spring, and governs a rotational frequency of Rota, i.e., ******, by applying brakes to a generator with a braking means of a roll control means.

[0011] A roll control means of a generator under the present circumstances, a reference signal output from an oscillator circuit, and a rotation detecting-signal output from a rotation detector In a speed comparator circuit, it compares for every period of a rotational wave form of Rota. By the comparison result a brake control circuit When a period of a rotation detecting signal is shorter than a period of said reference signal (i.e., when rotational speed of Rota is quicker than a reference signal output) A brake is

added to a period of the following one period of Rota, and Rota, and when a period of a rotation detecting signal is longer than a period of a reference signal (i.e., when rotational speed of Rota is slower than said reference signal output), it controls not to add a brake to a period of the following one period of Rota, and Rota.

[0012] For this reason, since brakes will continue being applied until rotational speed becomes slower than a reference signal output, when torque of sources of mechanical energy, such as a spiral spring, is large, rotation of a generator is progressing for example, and a condition that rotational speed of Rota is quicker than a reference signal output continues, it can govern to a quickly normal rotational speed, and quick control of responsibility can be performed.

[0013] Moreover, a period of a rotation detecting signal of Rota is shorter than a period of a reference signal, or it is long, or since a chisel was detected and brake control is set up, a configuration of a roll control means is simplified and cost can also be reduced.

[0014] Under the present circumstances, said speed comparison means is comparing signal level change timing after fixed time amount with output timing of the next rotation detecting signal of said rotation detecting signal from said rotation detecting signal of a reference signal output outputted according to a rotation detecting signal outputted from said rotation detector, and it is desirable to compare a period of a rotation detecting signal of Rota with a period of a reference signal.

[0015] Whenever it makes it output a reference signal output according to a rotation detecting signal, fixed timing can compare a next rotation detecting signal and a next reference signal output. For this reason, a comparison with a rotation detecting signal and a reference signal output can always be performed on exact and fixed criteria, also in the condition of Rota immediately after starting of a generator being stabilized and not rotating especially, a rotation condition of Rota can be grasped certainly and correctly, and suitable brake control can be performed.

[0016] Furthermore, in case said brake control circuit adds a brake to Rota, it may perform chopper brake control. If chopper brake control is performed, there is an advantage which can increase braking torque maintaining generated output more than fixed.

[0017] Moreover, while the electronics-control type machine clock of this invention is further equipped with the updown counter as which said rotation detecting signal and reference signal are inputted into a rise count input and a down count input, respectively, this updown counter may be constituted so that the progress / the delay output which has priority over an output of said brake control circuit, and controls a brake may output according to a counter value, when the cumulative error detection

output outputted according to a counter value is an ON state.

[0018] Like [when an impact joins the time of starting of a generator, and a clock], since brake control can be performed so that a cumulative error may be counted and the error may be abolished if it has such an updown counter, when rotation of Rota shifts greatly, the gap can be lost and it can return to a quickly normal control state.

[0019]

[Embodiment of the Invention] Below, the operation gestalt of this invention is explained based on a drawing.

[0020] Drawing 1 is the plan showing the important section of the electronics control type machine clock of the 1st operation gestalt of this invention, and drawing 2 and drawing 3 are the cross section.

[0021] The electronics control type machine clock is equipped with the barrel vehicle 1 which consists of spiral spring 1a, barrel gear 1b, barrel truth 1c, and 1d of barrel lids. As for spiral spring 1a, barrel gear 1b and an inner edge are fixed to barrel truth 1c for an outer edge. Barrel truth 1c is supported by a cope plate 2 and ****** 3, and it is being fixed with the angle hole screw 5 so that it may rotate by the angle hole vehicle 4 and one.

[0022] Although the angle hole vehicle 4 is rotated clockwise, ** has geared with ** 6 so that it may not rotate counterclockwise. In addition, since the method of rotating the angle hole vehicle 4 clockwise and rolling spiral spring 1a is the same as that of the automatic volume of a machine clock, or a **** device, explanation is omitted. It accelerates rotation of barrel gear 1b 7 times, and accelerates 6.4 times one by one to the No. 2 vehicle 7. To the No. 3 vehicle 8 9.375 It double-accelerates, and to the No. 4 vehicle 9, it accelerates 3 times, and it accelerates 10 times to the No. 5 vehicle 10, and a total of 126,000 times accelerates to the No. 6 vehicle 11 through each **** 7-11 which it accelerates 10 times and serves as accelerating **** to Rota 12.

[0023] The second hand 14 to which the minute hand 13 to which cylinder kana 7a performs a time stamp to cylinder kana 7a performs a time stamp in the No. 4 vehicle 9 is being fixed to the No. 2 vehicle 7, respectively. Therefore, what is necessary is just to control Rota 12 to rotate by 5rps, in order to rotate the No. 2 vehicle 7 by 1rph and to rotate the No. 4 vehicle 9 by 1rpm. Barrel gear 1b at this time is set to 1/7rph.

[0024] This electronics control type machine clock is equipped with Rota 12, the stator 15, and the generator 20 that consists of coil blocks 16. Rota 12 consists of Rota magnet 12a, Rota kana 12b, and Rota circle-of-inertia board 12c. Rota circle-of-inertia board 12c is for lessening rotational frequency fluctuation of Rota 12 to the driving torque fluctuation from the barrel vehicle 1. A stator 15 carries out the coil of the stator-coil 15b

of 40,000 turns to stator object 15a.

[0025] The coil block 16 carries out the coil of the coil 16b of 110,000 turns to core 16a. Here, stator object 15a and core 16a consist of PC permalloys etc. Moreover, stator-coil 15b and coil 16b are connected to the serial so that the output voltage which applied each generation-of-electrical-energy voltage may come out.

[0026] Next, the control circuit of an electronics control type machine clock is explained with reference to drawing 4 and 5.

[0027] The block diagram showing the electronics control type machine clock of this operation gestalt is shown in drawing 4 , and the circuit diagram is shown in drawing 5 .

[0028] the rectifier circuit 21 where the ac output from a generator 20 consists of pressure-up rectification, full wave rectification, half-wave rectification, transistor rectification, etc. -- letting it pass -- a pressure up -- it is rectified. The loads 22, such as ICs for control, such as a roll control means, and a quartz resonator, are connected to the rectifier circuit 21. In addition, drawing 4 has indicated independently [a load 22] each functional circuit of explanation constituted in IC for convenience.

[0029] The brake circuit 23 from which it connected with the serial and transistor 23B of damping resistance 23A and Nch, or Pch was constituted by the generator 20 is connected to juxtaposition. The roll control means 50 is connected to the brake circuit 23. In addition, the diode other than damping resistance 23A may be suitably inserted in a brake circuit 23.

[0030] The roll control means 50 is constituted by an oscillator circuit 51, the frequency divider 52, the rotation detector 53, the speed (frequency) comparator circuit 54, and the brake control circuit 56.

[0031] An oscillator circuit 51 outputs an oscillation signal using quartz-resonator 51A, and dividing of this oscillation signal is carried out by the frequency divider 52 to a certain fixed period. With this operation gestalt, as shown in drawing 5 , it has two frequency dividers 52A and 52B. In addition, a reference signal may be created using various kinds of criteria standard sources of vibration etc. instead of quartz-resonator 51A.

[0032] Frequency divider 52A outputs the 16kHz pulse signal for making the reset pulse mentioned later. Frequency divider 52B outputs a 10Hz reference clock (reference signal) to the speed comparator circuit 54.

[0033] It has four flip-flops 61-64, and the inverter (reversal) gates 65 and 66 and the AND gates 67, and the speed comparator circuit 54 is constituted, as shown in drawing 5 .

[0034] Flip-flops 61 and 62, the inverter gate 65, and the AND gate 67 are used in order

to create the counter reset pulse 70 in the timing chart of drawing 6 , and they are constituted so that the counter reset pulse 70 may be outputted corresponding to the standup of a motor pulse (rotation detecting signal). In addition, each flip-flops 61-64 are constituted so that data may be outputted to outputs 1Q-4Q at the time of falling of a clock.

[0035] The flip-flop 63 is constituted so that the reference clock from frequency divider 52B which is reset by said counter reset pulse 70 and is similarly reset by the reset pulse 70 may be received by the clocked into. And in this circuit, since ground level is set as H level, according to the time of falling of a reference clock, H level signal is outputted from output 3Q (refer to the timing chart of drawing 6). Therefore, if the following motor pulse will be inputted by the time of falling change of a reference clock and a reset pulse 70 is outputted, output 3Q will not change with L level signal (refer to 2 period eye from the left of drawing 6).

[0036] The flip-flop 64 into which output 3Q is inputted Since a brake control pulse is outputted and the motor pulse is inputted into the clocked into through the inverter gate 66, As for the following period to which, as for the following period to which H level signal was outputted from output 3Q, the signal (brake control OFF) of H level was outputted from output 4Q, and L level signal was outputted from output 3Q, L level signal (brake control ON) is outputted.

[0037] Output 4Q of this flip-flop 64 is outputted to the gate of transistor 23B of Pch as it is. Therefore, if L level signal is outputted from this output 4Q, it will be maintained by ON condition, a generator 20 will short-circuit, and transistor 23B will require a brake.

[0038] On the other hand, if H level signal is outputted from output 4Q, in order that the gate voltage of transistor 23B may go up, transistor 23B is maintained by the OFF condition and a brake does not join a generator 20. Therefore, this speed comparator circuit 54 is also making the brake control circuit 56 serve a double purpose.

[0039] Next, the actuation in this operation gestalt is explained also with reference to the timing chart of drawing 6 .

[0040] If a generator 20 begins to operate and a motor pulse (rotation detecting signal) is detected in the rotation detector 53, each flip-flop 61 and the reset pulse 70 which synchronized with the motor pulse in 62 grades will be generated first.

[0041] And frequency divider 52B reset by this reset pulse 70 outputs the reference clock (10Hz) on the basis of a reset pulse 70 to a flip-flop 63. Therefore, a flip-flop 63 generates the signal which starts from a reset pulse 70 after fixed time amount (this operation gestalt 100msec(s)) progress in output 3Q. However, since a flip-flop 63 is also

reset when the following motor pulse is inputted and a reset pulse 70 is generated before fixed time amount progress (i.e., when the standup timing of the following motor pulse is earlier than the falling timing of a reference clock), output 3Q is maintained with the condition of L level.

[0042] And output 4Q of a flip-flop 64 When H level signal is outputted from 3Q (i.e., when the standup timing of the following motor pulse is later than the falling timing of a reference clock) The signal (H level signal) which turns off the period of one period of the following motor pulse and a brake is outputted. On the contrary, when L level signal is outputted from 3Q (i.e., when the standup timing of the following motor pulse is earlier than the falling timing of a reference clock), the signal (L level signal) which turns on the period of one period of the following motor pulse and a brake is outputted.

[0043] Thereby, when a period is [a motor pulse] short, that is, the rotational speed of a generator 20 is high compared with a reference clock, since the brake circuit 23 of a generator 20 is turned on, a brake is added, and the brake circuit 23 of a generator 20 is turned off by reverse when [that the period of a motor pulse is long that is,] the rotational speed of a generator 20 is low, and a brake is taken off compared with a reference clock, governing of a generator 20 is performed.

[0044] in addition -- although the reference signal of frequency divider 52B has a time lag between the standup timing of a motor pulse since it is generated according to the timing of falling of the counter reset pulse 70 -- this gap -- the case of this operation gestalt -- max -- about 61microsec it is -- while it is very small, since most gap time amount is regularity, in case it compares each motor pulse with a reference signal, that effect can also abolish it.

[0045] According to such this operation gestalt, there are the following effects.

[0046] ** Compare the rotation detecting signal (motor pulse) of Rota 12 with a reference signal (reference clock). Since very simple control of detecting whether the period of a rotation detecting signal being short or long compared with the period of a reference signal, applying the period brakes of the following one period of Rota 12 in being short, and not applying brakes in being long is performed Circuitry can be simplified, components cost and a manufacturing cost can be reduced, and an electronics control type machine clock can be offered cheaply.

[0047] ** If the condition that the period of a rotation detecting signal is short continues compared with the period of a reference signal since brake control is performed for every period of Rota 12 for example, even when it can continue applying brakes and the rotation periods at the time of the standup of a generator 20 etc. are shifted more greatly than a criteria period, it can bring close to criteria speed quickly, and

responsibility of governing control can be made quick.

[0048] ** Since it is reset by the reset pulse 70 based on a motor pulse, frequency divider 52B can synchronize a motor pulse and a reference signal, since the reference signal compared with a motor pulse can always be done to a fixed period from a reset pulse 70, can always judge correctly the progress/delay over the reference signal of a motor pulse, and can perform brake control.

[0049] Since the period of a motor pulse is not fixed especially immediately after starting of a generator 20, either, there is a possibility that a phase with a reference signal may shift and an exact comparison may become impossible, but since a reference signal is reset and it is made to synchronize with a motor pulse by the reset pulse 70 for every period of a motor pulse with this operation gestalt, also immediately after starting of a generator 20, exact brake control can be performed and the stability of a system can also be secured.

[0050] ** Although the generating period of a motor pulse has velocity turbulence in the short term since each period of a motor pulse is always compared with a reference signal and you are making it reflected in brake control of the motor pulse just behind that, continuing changing over long duration can be prevented. For this reason, there is no wandering of movement which is the degree which people can recognize by speed change of a generator 20 at the time of movement of an electronics control type machine clock, and though it is a simple configuration, it can offer the electronics control type machine clock which is satisfactory practically.

[0051] Next, the 2nd operation gestalt of this invention is explained with reference to drawing 7 and 8. in addition, this operation gestalt -- setting -- the component the same as that of the above-mentioned 1st operation gestalt, or same -- the same sign -- giving -- explanation -- an abbreviation -- or it carries out simple.

[0052] As this operation gestalt is shown in drawing 7 , only the point of having formed the chopper ring circuit 80 which consists of NAND gate 83 where the output of the inverter gate 81, the chopper pulse generating circuit 82 of several several 10Hz - kHz (for example, 10Hz - 10kHz) degree, the inverter gate 81, and the chopper pulse generating circuit 82 is inputted into output 4Q of a flip-flop 64 is different from said 1st operation gestalt.

[0053] With this operation gestalt of this, if L level signal which turns on a brake circuit 23 from a flip-flop 64 is outputted as shown in the timing chart of drawing 8 , a generator 20 will also be controlled by becoming a chopper brake control output and transistor 23B being turned on and off by the chopper ring circuit 80 with this output by the chopper brake.

[0054] Also in such this operation gestalt, when the same effect as ** of said 1st operation gestalt - ** is acquired, there is an effect which can increase braking torque, maintaining generated output more than fixed, since ** chopper ring control is performed. That is, by turning on and off and carrying out the chopper ring of the transistor 23B which can short-circuit the coil both ends of a generator 20, when transistor 23B is turned on, short brakes are applied to a generator 20, and the coil of a generator 20 is covered with energy. On the other hand, if transistor 23B is turned off, a generator 20 operates, and since a part for the energy with which said coil was covered is contained, an electromotive voltage will increase. For this reason, if a generator 20 is controlled by the chopper ring, the fall of the generated output at the time of a brake can be filled up by part for the rise of the electromotive voltage at the time of switch-off, damping torque can be increased, maintaining generated output more than fixed, and the long electronics control type machine clock of the persistence time can be constituted.

[0055] Next, the 3rd operation gestalt of this invention is explained with reference to drawing 9 and 10. in addition, this operation gestalt -- setting -- the component the same as that of the above-mentioned 1st operation gestalt, or same -- the same sign -- giving -- explanation -- an abbreviation -- or it carries out simple.

[0056] This operation gestalt is equipped with the updown counter 92 by which the motor pulse was considered as the rise count input, and the output (reference signal: 10Hz) of the frequency divider 91 which is not reset was considered as the down count input as shown in drawing 9 . The cumulative error of the motor pulse over a reference signal is counted by carrying out counting of the motor pulse from the time of starting of a generator 20, and the output of a frequency divider 91, and measuring them by this updown counter 92.

[0057] When a cumulative error becomes large when H level signal is usually outputted to this updown counter 92 and said counter value crosses a fixed range that is, the cumulative error detection output which outputs L level signal, and the progress / delay output which outputs the signal (H level signal) which will output the signal (L level signal) which turns on a brake if said cumulative error is the direction of motor pulse advance, and turns off a brake if it is the direction of delay are prepared. In addition, as for progress / delay output, the cumulative error detection output is maintained at L level at the period of H level.

[0058] Said cumulative error detection output is inputted into the AND gate 93 with output 4Q of a flip-flop 64, and the output of this AND gate 93 is inputted into the OR gate 94 with said progress / delay output.

[0059] With such this operation gestalt, a motor pulse and the reference signal of a frequency divider 91 count by the updown counter 92 to starting of a generator 20 and coincidence. When the difference of the enumerated data of a motor pulse and the enumerated data of a reference signal has fallen [the counted value of an updown counter 92] within the fixed range in the set point that is, based on output 4Q of a flip-flop 64, brake control is performed like said 1st operation gestalt.

[0060] If the generator 20 is rotating quickly, the enumerated data of a motor pulse become larger than the enumerated data of a reference signal on the other hand and the difference becomes beyond the set point, a cumulative error detection output will serve as L level. For this reason, a mask is applied to output 4Q of a flip-flop 64, the output of the AND gate 93 is always set to L level, and output 4Q is canceled.

[0061] For this reason, the signal of progress / delay output is outputted to a brake circuit 23, and a brake is controlled so that this abolishes a cumulative error. That is, when the enumerated data of a motor pulse are larger than the enumerated data of a reference signal, L level signal is outputted, a brake is turned on compulsorily, when the enumerated data of a motor pulse are smaller than the enumerated data of a reference signal, H level signal is outputted and a brake is turned off compulsorily.

[0062] According to such this operation gestalt, when the same effect as ** of said 1st operation gestalt - ** is acquired, there is the following effect.

[0063] ** Since the updown counter 92 is formed, when the cumulative error of the motor pulse advance / delay over a reference signal can be counted and a cumulative error becomes large beyond the set point, brake control can be performed so that that cumulative error may be abolished, for this reason, when the cumulative error has arisen, it can return to normal control quickly, and the responsibility of governing control can be raised further.

[0064] In addition, this invention is not limited to said each operation gestalt, and the deformation in the range which can attain the purpose of this invention, amelioration, etc. are included in this invention.

[0065] For example, the chopper ring circuit 80 of the 2nd operation gestalt is established in the output side of the OR gate 94, and you may enable it to perform chopper ring control also in the 3rd operation gestalt in said 3rd operation gestalt.

[0066] Moreover, what is necessary is just to set up suitably the concrete configuration of the speed comparator circuit 54 or the brake control circuit 56 not only according to said each operation gestalt but according to the configuration of the brake circuits 23 when transistor 23B of Nch is used etc. Moreover, what is necessary is just to set up suitably the output of frequency divider 52A which the counter reset pulse 70 generates

not only according to a 16kHz pulse signal but according to the rotation period of Rota 12 etc.

[0067] Furthermore, what is necessary is just to set up suitably the means which compares the period of the rotation detecting signal of Rota, and a reference signal not only according to the thing of each of said operation gestalt but according to a configuration.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the plan showing the important section of the electronics control type machine clock in the 1st operation gestalt of this invention.

[Drawing 2] It is the cross section showing the important section of drawing 1 .

[Drawing 3] It is the cross section showing the important section of drawing 1 .

[Drawing 4] It is the block diagram showing the configuration of this operation gestalt.

[Drawing 5] It is the circuit diagram showing the configuration of the roll control means of this operation gestalt.

[Drawing 6] It is a timing chart in the circuit of this operation gestalt.

[Drawing 7] It is the circuit diagram showing the configuration of the 2nd operation gestalt of this invention.

[Drawing 8] It is a timing chart in the circuit of the 2nd operation gestalt.

[Drawing 9] It is the circuit diagram showing the configuration of the 3rd operation gestalt of this invention.

[Drawing 10] It is a timing chart in the circuit of the 3rd operation gestalt.

[Description of Notations]

1 Barrel Vehicle

1a Spiral spring

3 ******

7 No. 2 Vehicle

8 No. 3 Vehicle

9 No. 4 Vehicle

10 No. 5 Vehicle

11 No. 6 Vehicle

12 Rota

13 Minute Hand

14 Second Hand

15 Stator
16 Coil Block
20 Generator
21 Rectifier Circuit
22 Load
23 Brake Circuit
23A Damping resistance
23B Transistor
50 Roll Control Means
51 Oscillator Circuit
51A Quartz resonator
52, 91, 52A, 52B Frequency divider
53 Rotation Detector
54 Speed Comparator Circuit
56 Brake Control Circuit
61-64 Flip-flop
70 Counter Reset Pulse
80 Chopper Ring Circuit
82 Chopper Pulse Generating Circuit
92 Updown Counter

[Translation done.]

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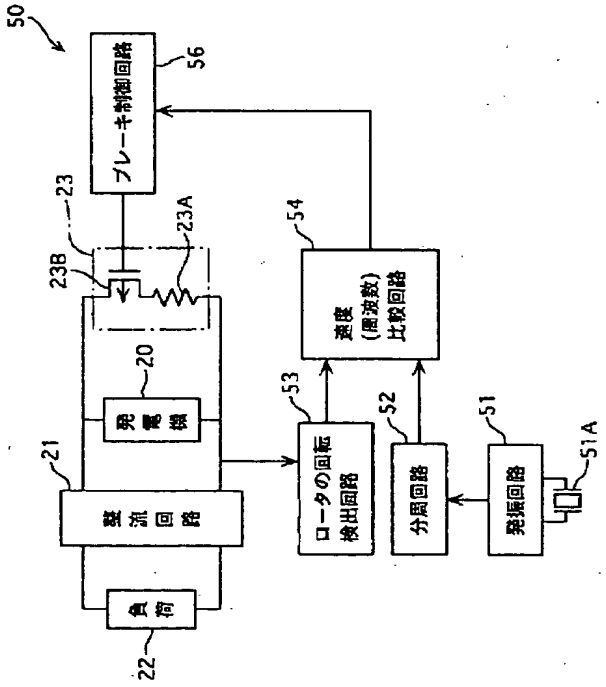
(54)【発明の名称】　電子制御式機械時計

(57)【要約】

【課題】　調速制御の応答性が速く、かつコストも低減できる電子制御式機械時計を提供すること。

【解決手段】　電子制御式機械時計は、ゼンマイ１ａから輪列を介して伝達される機械エネルギを電気エネルギに変換する発電機２０と、変換した電気エネルギで駆動されて発電機２０の回転周期を制御する回転制御手段５０とを備える。回転制御手段５０は、ロータの回転波形の１周期毎に回転検出回路５３からの回転検出信号と分周回路５２からの基準信号とを比較する速度比較回路５４と、速度比較回路５４で回転検出信号の周期が基準信号の周期よりも短い場合には、ロータの次の１周期の間、ロータにブレーキを加え、長い場合には、ブレーキを加えないように制御するブレーキ制御回路５６とを有する。



【特許請求の範囲】

【請求項１】　ゼンマイと、輪列を介して伝達されるゼンマイの機械エネルギを電気エネルギに変換する発電機と、前記輪列に結合された指針と、変換した前記電気エネルギにより駆動されて前記発電機の回転周期を制御する回転制御手段とを備える電子制御式機械時計において、

前記回転制御手段は、時計の時間標準となる基準信号を作る発振回路と、前記発電機のロータの回転を検出する回転検出回路と、前記発振回路の基準信号出力と前記回転検出回路の回転検出信号出力とをロータの回転波形の１周期毎に比較する速度比較回路と、この速度比較回路において前記回転検出信号の周期が前記基準信号の周期よりも短い場合には、ロータの次の１周期の期間、ロータにブレーキを加え、回転検出信号の周期が基準信号の周期よりも長い場合には、ロータの次の１周期の期間、ロータにブレーキを加えないように制御するブレーキ制御回路とを有することを特徴とする電子制御式機械時計。

【請求項２】　請求項１に記載の電子制御式機械時計において、前記速度比較回路は、前記回転検出回路から出力される回転検出信号に合わせて出力される基準信号出力の前記回転検出信号から一定時間後の信号レベル変化タイミングと、前記回転検出信号の次の回転検出信号の出力タイミングとを比較することで、回転検出信号の周期と基準信号の周期とを比較することを特徴とする電子制御式機械時計。

【請求項３】　請求項１または２に記載の電子制御式機械時計において、前記ブレーキ制御回路は、ロータにブレーキを加える際に、チョッパブレーキ制御を行うことを特徴とする電子制御式機械時計。

【請求項４】　請求項１～３のいずれかに記載の電子制御式機械時計において、前記回転検出信号と基準信号とがそれぞれアップカウント入力およびダウンカウント入力に入力されるアップダウンカウンタを備えるとともに、このアップダウンカウンタは、カウンタ値に応じて出力される累積誤差検出出力がオン状態となっている場合には、前記ブレーキ制御回路の出力に優先してブレーキを制御する進み／遅れ出力をカウンタ値に応じて出力するように構成されていることを特徴とする電子制御式機械時計。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、ゼンマイが開放する時の機械エネルギを発電機で電気エネルギに変換し、その電気エネルギにより回転制御手段を作動させて発電機の回転周期を制御することにより、輪列に固定される指針を正確に駆動する電子制御式機械時計に関する。

【０００２】

【背景技術】ゼンマイが開放する時の機械エネルギを発電機で電気エネルギに変換し、その電気エネルギにより回転制御手段を作動させて発電機のコイルに流れる電流値を制御することにより、輪列に固定される指針を正確に駆動して正確に時刻を表示する電子制御式機械時計として、特公平７－１１９８１２号公報や特開平８－５０１８６号公報に記載されたものが知られている。

【０００３】特公平７－１１９８１２号公報に記載されたものは、ロータが１回転する間つまり基準信号の周期毎に、ブレーキをオフしてロータの回転速度を高めて発電量を増やす角度範囲と、ブレーキを掛けて低速で回す角度範囲とを設け、前記回転速度が高い間で発電電力を向上させつつ、ブレーキ時の発電電力の低下を補うようにして調速していた。

【０００４】また、特開平８－５０１８６号公報に記載されたものは、基準パルスとロータの回転に伴い検出される測定パルスとをカウントし、かつ基準パルスの数と測定パルスの数とを比較し、基準パルスの数が測定パルスの数よりも小さい第１の状態では、制御手段により前記測定パルスに応答してパルス幅が設定されたブレーキ信号を発生してブレーキ制御を行っていた。

【０００５】

【発明が解決しようとする課題】しかしながら、特公平７－１１９８１２号公報に記載したものは、ロータが１回転する間つまり基準信号毎にブレーキのオン制御とオフ制御とが必ず行われているため、特に発電機の立ち上がり時等や制御が大きく外れた場合等に、各基準信号毎のロータの回転制御量はそれほど大きくできず、正常な制御状態に移行するまでに時間がかかり、応答性が低いという問題があった。

【０００６】また、特開平８－５０１８６号公報に記載したものも、基準信号毎に発生するブレーキ信号はそのパルス幅が一定のため、制御が大きく外れた場合などにも各基準信号毎のブレーキ量は一定であるため、正常な制御状態に移行するまでに時間がかかり、応答性が低いという同じ問題があった。

【０００７】その上、基準パルス、測定パルスのカウントおよび比較によって第１、第２の状態を検出する回路のほかに、その測定パルスに応答してパルス幅が設定されたブレーキ信号を発生する制御手段を別途設ける必要があり、構成が複雑になってコストが高いという問題もあった。

【０００８】本発明の目的は、調速制御の応答性が速く、かつコストも低減できる電子制御式機械時計を提供することにある。

【０００９】

【課題を解決するための手段】本発明の電子制御式機械時計は、ゼンマイと、輪列を介して伝達されるゼンマイの機械エネルギを電気エネルギに変換する発電機と、前記輪列に結合された指針と、変換した前記電気エネルギにより駆動されて前記発電機の回転周期を制御する回転

制御手段とを備える電子制御式機械時計において、前記回転制御手段は、水晶振動子等を用いて時計の時間標準となる基準信号を作る発振回路と、前記発電機のロータの回転を検出する回転検出回路と、前記発振回路の基準信号出力と前記回転検出回路の回転検出信号出力とをロータの回転波形の１周期毎に比較する速度比較回路と、この速度比較回路において前記回転検出信号の周期が前記基準信号の周期よりも短い場合には、ロータの次の１周期の期間、ロータにブレーキを加え、回転検出信号の周期が基準信号の周期よりも長い場合には、ロータの次の１周期の期間、ロータにブレーキを加えないように制御するブレーキ制御回路とを有することを特徴とするものである。

【００１０】本発明の電子制御式機械時計は、指針及び発電機をゼンマイで駆動し、発電機に回転制御手段の制動手段によりブレーキをかけることでロータつまりは指針の回転数を調速する。

【００１１】この際、発電機の回転制御手段は、発振回路からの基準信号出力と回転検出回路からの回転検出信号出力とを、速度比較回路においてロータの回転波形の１周期毎に比較し、その比較結果によりブレーキ制御回路は、回転検出信号の周期が前記基準信号の周期よりも短い場合、つまりロータの回転速度が基準信号出力よりも速い場合には、ロータの次の１周期の期間、ロータにブレーキを加え、回転検出信号の周期が基準信号の周期よりも長い場合、つまりロータの回転速度が前記基準信号出力よりも遅い場合には、ロータの次の１周期の期間、ロータにブレーキを加えないように制御する。

【００１２】このため、例えば、ゼンマイなどの機械的エネルギ源のトルクが大きくて発電機の回転が進んでおり、ロータの回転速度が基準信号出力よりも速い状態が続いている場合には、回転速度が基準信号出力よりも遅くなるまでの間、ブレーキをかけ続けることになるため、迅速に正常な回転速度に調速することができ、応答性の速い制御を行うことができる。

【００１３】また、ロータの回転検出信号の周期が基準信号の周期よりも短いか長いかのみを検出してブレーキ制御を設定しているので、回転制御手段の構成が簡略化されてコストも低減できる。

【００１４】この際、前記速度比較手段は、前記回転検出回路から出力される回転検出信号に合わせて出力される基準信号出力の前記回転検出信号から一定時間後の信号レベル変化タイミングと、前記回転検出信号の次の回転検出信号の出力タイミングとを比較することで、ロータの回転検出信号の周期と基準信号の周期とを比較することが好ましい。

【００１５】基準信号出力を回転検出信号に合わせて出力するようにすれば、次の回転検出信号と基準信号出力とを常に一定のタイミングで比較することができる。このため、回転検出信号と基準信号出力との比較を常に正確にかつ一定の基準で行うことができ、特に発電機の起動直後のロータが安定して回転していない状態でも、確実にかつ正確にロータの回転状態を把握して適切なブレーキ制御を行うことができる。

【００１６】さらに、前記ブレーキ制御回路は、ロータにブレーキを加える際に、チョッパブレーキ制御を行うものでもよい。チョッパブレーキ制御を行えば、発電電力を一定以上に保ちながら、ブレーキトルクを増加できる利点がある。

【００１７】また、本発明の電子制御式機械時計は、さらに前記回転検出信号と基準信号とがそれぞれアップカウント入力およびダウンカウント入力に入力されるアップダウンカウンタを備えるとともに、このアップダウンカウンタは、カウンタ値に応じて出力される累積誤差検出出力がオン状態となっている場合には、前記ブレーキ制御回路の出力に優先してブレーキを制御する進み／遅れ出力をカウンタ値に応じて出力するように構成されているものでもよい。

【００１８】このようなアップダウンカウンタを備えていれば、累積誤差をカウントしてその誤差を無くすようにブレーキ制御を行うことができるため、発電機の起動時や時計に衝撃が加わった場合のように、ロータの回転が大きくずれた際に、そのずれを無くして迅速に正常な制御状態に戻すことができる。

【００１９】

【発明の実施の形態】以下に、本発明の実施形態を図面に基づいて説明する。

【００２０】図１は、本発明の第１実施形態の電子制御式機械時計の要部を示す平面図であり、図２及び図３はその断面図である。

【００２１】電子制御式機械時計は、ゼンマイ１ａ、香箱歯車１ｂ、香箱真１ｃ及び香箱蓋１ｄからなる香箱車１を備えている。ゼンマイ１ａは、外端が香箱歯車１ｂ、内端が香箱真１ｃに固定される。香箱真１ｃは、地板２と輪列受３に支持され、角穴車４と一体で回転するように角穴ネジ５により固定されている。

【００２２】角穴車４は、時計方向には回転するが反時計方向には回転しないように、こはぜ６と噛み合っている。なお、角穴車４を時計方向に回転しゼンマイ１ａを巻く方法は、機械時計の自動巻または手巻機構と同様であるため、説明を省略する。香箱歯車１ｂの回転は、７倍に増速されて二番車７へ、順次６．４倍増速されて三番車８へ、9.375 倍増速されて四番車９へ、３倍増速されて五番車１０へ、１０倍増速されて六番車１１へ、１０倍増速されてロータ１２へと、増速輪列となる各番車７～１１を介して合計１２６，０００倍に増速されている。

【００２３】二番車７には筒かな７ａが、筒かな７ａには時刻表示を行う分針１３が、四番車９には時刻表示を行う秒針１４がそれぞれ固定されている。従って、二番

車７を１ｒｐｈで、四番車９を１ｒｐｍで回転させるためには、ロータ１２は５ｒｐｓで回転するように制御すればよい。このときの香箱歯車１ｂは、１／７ｒｐｈとなる。

【００２４】この電子制御式機械時計は、ロータ１２、ステータ１５、コイルブロック１６から構成される発電機２０を備えている。ロータ１２は、ロータ磁石１２ａ、ロータかな１２ｂ、ロータ慣性円板１２ｃから構成される。ロータ慣性円板１２ｃは、香箱車１からの駆動トルク変動に対しロータ１２の回転数変動を少なくするためのものである。ステータ１５は、ステータ体１５ａに４万ターンのステータコイル１５ｂを巻線したものである。

【００２５】コイルブロック１６は、磁心１６ａに１１万ターンのコイル１６ｂを巻線したものである。ここで、ステータ体１５ａと磁心１６ａはＰＣパーマロイ等で構成されている。また、ステータコイル１５ｂとコイル１６ｂは、各々の発電電圧を加えた出力電圧がでるように直列に接続されている。

【００２６】次に、電子制御式機械時計の制御回路について、図４，５を参照して説明する。

【００２７】図４には、本実施形態の電子制御式機械時計を示すブロック図が示され、図５には、その回路図が示されている。

【００２８】発電機２０からの交流出力は、昇圧整流、全波整流、半波整流、トランジスタ整流等からなる整流回路２１を通して昇圧、整流される。整流回路２１には、回転制御手段等の制御用ＩＣや水晶振動子等の負荷２２が接続されている。なお、図４では説明の便宜上、ＩＣ内に構成される各機能回路を負荷２２とは別に記載している。

【００２９】発電機２０には、制動抵抗２３ＡおよびＮｃｈやＰｃｈのトランジスタ２３Ｂが直列に接続されて構成されたブレーキ回路２３が並列に接続されている。ブレーキ回路２３には、回転制御手段５０が接続されている。なお、ブレーキ回路２３には、制動抵抗２３Ａのほかにダイオードを適宜挿入してもよい。

【００３０】回転制御手段５０は、発振回路５１、分周回路５２、回転検出回路５３、速度（周波数）比較回路５４、ブレーキ制御回路５６によって構成されている。

【００３１】発振回路５１は水晶振動子５１Ａを用いて発振信号を出力し、この発振信号は分周回路５２によってある一定周期まで分周される。本実施形態では、図５に示すように、２つの分周回路５２Ａ、５２Ｂを有する。なお、水晶振動子５１Ａの代わりに各種の基準標準振動源等を用いて基準信号を作成してもよい。

【００３２】分周回路５２Ａは、後述するリセットパルスを作るための１６ｋＨｚのパルス信号を出力する。分周回路５２Ｂは、１０Ｈｚの基準クロック（基準信号）を速度比較回路５４に出力する。

【００３３】速度比較回路５４は、図５に示すように、４つのフリップフロップ６１～６４と、インバータ（反転）ゲート６５，６６、ＡＮＤゲート６７とを備えて構成されている。

【００３４】フリップフロップ６１，６２、インバータゲート６５、ＡＮＤゲート６７は、図６のタイミングチャートにおけるカウンタリセットパルス７０を作成するために用いられ、モータパルス（回転検出信号）の立ち上がりに対応してカウンタリセットパルス７０が出力されるように構成されている。なお、各フリップフロップ６１～６４は、クロックの立ち下がり時にデータを出力１Ｑ～４Ｑに出力するように構成されている。

【００３５】フリップフロップ６３は、前記カウンタリセットパルス７０によってリセットされ、同じくリセットパルス７０でリセットされる分周回路５２Ｂからの基準クロックをそのクロック入力で受けるように構成されている。そして、本回路では、アースレベルがＨレベルに設定されているので、基準クロックの立ち下がり時に合わせて出力３ＱからＨレベル信号が出力される（図６のタイミングチャート参照）。従って、基準クロックの立ち下がり変化時までに次のモータパルスが入力されてリセットパルス７０が出力されると、出力３ＱはＬレベル信号のままで変化しない（図６の左から２周期目参照）。

【００３６】出力３Ｑが入力されるフリップフロップ６４は、ブレーキ制御パルスを出力するものであり、そのクロック入力にモータパルスをインバータゲート６６を通して入力しているため、出力３ＱからＨレベル信号が出力された次の周期は、出力４ＱからはＨレベルの信号（ブレーキ制御ＯＦＦ）が出力され、出力３ＱからＬレベル信号が出力された次の周期は、Ｌレベル信号（ブレーキ制御ＯＮ）が出力される。

【００３７】このフリップフロップ６４の出力４Ｑは、そのままＰｃｈのトランジスタ２３Ｂのゲートに出力される。従って、この出力４ＱからＬレベル信号が出力されると、トランジスタ２３ＢはＯＮ状態に維持され、発電機２０がショートされてブレーキが掛かる。

【００３８】一方、出力４ＱからＨレベル信号が出力されると、トランジスタ２３Ｂのゲート電圧が上がるため、トランジスタ２３ＢはＯＦＦ状態に維持され、発電機２０にはブレーキが加わらない。従って、この速度比較回路５４はブレーキ制御回路５６も兼用している。

【００３９】次に、本実施形態における動作を図６のタイミングチャートをも参照して説明する。

【００４０】発電機２０が作動し始めて回転検出回路５３でモータパルス（回転検出信号）が検出されると、まず各フリップフロップ６１、６２等でモータパルスに同期したリセットパルス７０が発生される。

【００４１】そして、このリセットパルス７０によってリセットされる分周回路５２Ｂは、リセットパルス７０

を基点とする基準クロック（１０Ｈｚ）をフリップフロップ６３に出力する。従って、フリップフロップ６３は、リセットパルス７０から一定時間（本実施形態では１００msec）経過後に立ち上がる信号を出力３Ｑで発生する。但し、一定時間経過前に、次のモータパルスが入力されてリセットパルス７０が発生された場合、つまり基準クロックの立ち下がりタイミングよりも、次のモータパルスの立ち上がりタイミングが早い場合には、フリップフロップ６３もリセットされるため、出力３ＱはＬレベルの状態のまま維持される。

【００４２】そして、フリップフロップ６４の出力４Ｑは、３ＱからＨレベル信号が出力される場合、つまり基準クロックの立ち下がりタイミングよりも、次のモータパルスの立ち上がりタイミングが遅い場合には、次のモータパルスの１周期の期間、ブレーキをＯＦＦする信号（Ｈレベル信号）を出力し、逆に、３ＱからＬレベル信号が出力される場合、つまり基準クロックの立ち下がりタイミングよりも、次のモータパルスの立ち上がりタイミングが早い場合には、次のモータパルスの１周期の期間、ブレーキをＯＮする信号（Ｌレベル信号）を出力する。

【００４３】これにより、基準クロックに比べてモータパルスが周期が短い、つまり発電機２０の回転速度が高い場合には、発電機２０のブレーキ回路２３がＯＮされてブレーキが加わり、逆に基準クロックに比べてモータパルスの周期が長い、つまり発電機２０の回転速度が低い場合には、発電機２０のブレーキ回路２３がＯＦＦされてブレーキが解除されるため、発電機２０の調速が行われる。

【００４４】なお、分周回路５２Ｂの基準信号は、カウンタリセットパルス７０の立ち下がりのタイミングに合わせて発生されるため、モータパルスの立ち上がりタイミングとの間に時間的ずれがあるが、このずれは本実施形態の場合、最大でも約６１μsec であり、非常に小さいとともに、ずれ時間はほとんど一定であるから、各モータパルスを基準信号と比較する際にその影響も無くすことができる。

【００４５】このような本実施形態によれば、次のような効果がある。

【００４６】①ロータ１２の回転検出信号（モータパルス）と、基準信号（基準クロック）とを比較し、基準信号の周期に比べて回転検出信号の周期が短いか長いかを検出し、短い場合にはロータ１２の次の１周期の期間ブレーキを掛け、長い場合にはブレーキを掛けないという非常にシンプルな制御を行っているので、回路構成を簡単にでき、部品コストや製造コストを低減でき、電子制御式機械時計を安価に提供できる。

【００４７】②ブレーキ制御をロータ１２の１周期毎に行っているため、例えば、基準信号の周期に比べて回転検出信号の周期が短い状態が続けば、ブレーキを掛け続けることもでき、発電機２０の立ち上がり時等の回転周期が基準周期よりも大きくずれている場合でも、迅速に基準速度に近づけることができ、調速制御の応答性を速くすることができる。

【００４８】③分周回路５２Ｂは、モータパルスに基づくリセットパルス７０でリセットされているので、モータパルスと基準信号とを同期させることができ、モータパルスと比較される基準信号を常にリセットパルス７０から一定周期にできるため、モータパルスの基準信号に対する進み／遅れを常に正確に判断してブレーキ制御を行うことができる。

【００４９】特に、発電機２０の起動直後は、モータパルスの周期も一定していないため、基準信号との位相がずれて正確な比較ができなくなるおそれがあるが、本実施形態ではモータパルスの１周期毎にリセットパルス７０によって基準信号をリセットし、モータパルスと同期させているので、発電機２０の起動直後でも、正確なブレーキ制御を行うことができてシステムの安定性も確保できる。

【００５０】④常にモータパルスの各周期と、基準信号とを比較してその直後のモータパルスのブレーキ制御に反映させているため、モータパルスの発生周期は、短期的には速度変動があるが、長時間にわたって変動し続けることは防止できる。このため、電子制御式機械時計の運針時に、発電機２０の速度変化によって人が認知できる程度の運針のふらつきはなく、シンプルな構成でありながら、実用上問題のない電子制御式機械時計を提供することができる。

【００５１】次に、本発明の第２実施形態について図７，８を参照して説明する。なお、本実施形態において、前述の第１実施形態と同一もしくは同様の構成部分には、同一符号を付し、説明を省略あるいは簡略する。

【００５２】本実施形態は、図７に示すように、フリップフロップ６４の出力４Ｑに、インバータゲート８１、数１０Ｈｚ～数ｋＨｚ（例えば１０Ｈｚ～１０ｋＨｚ）程度のチョッパパルス発生回路８２、インバータゲート８１およびチョッパパルス発生回路８２の出力が入力されるＮＡＮＤゲート８３とからなるチョッパリング回路８０を設けた点のみが前記第１実施形態と相違する。

【００５３】この本実施形態では、図８のタイミングチャートに示すように、フリップフロップ６４からブレーキ回路２３をＯＮするＬレベル信号が出力されると、チョッパリング回路８０によってチョッパブレーキ制御出力となり、この出力でトランジスタ２３Ｂがオンオフされることで、発電機２０もチョッパブレーキによって制御される。

【００５４】このような本実施形態においても、前記第１実施形態の①～④と同じ効果が得られる上、⑤チョッパリング制御を行っているので、発電電力を一定以上に保ちながら、ブレーキトルクを増加できる効果もある。

すなわち、発電機２０のコイル両端を短絡可能なトランジスタ２３Ｂをオン・オフしてチョッパリングすることで、トランジスタ２３Ｂをオンした時には、発電機２０にショートブレーキが掛かり、かつ発電機２０のコイルにエネルギーがたまる。一方で、トランジスタ２３Ｂをオフすると、発電機２０が動作し、前記コイルにたまっていたエネルギー分が含まれるため、起電圧が高まる。このため、発電機２０をチョッパリングで制御すると、ブレーキ時の発電電力の低下を、スイッチオフ時の起電圧の高まり分で補填でき、発電電力を一定以上に保ちながら制動トルクを増加でき、持続時間の長い電子制御式機械時計を構成することができる。

【００５５】次に、本発明の第３実施形態について図９，１０を参照して説明する。なお、本実施形態において、前述の第１実施形態と同一もしくは同様の構成部分には、同一符号を付し、説明を省略あるいは簡略する。

【００５６】本実施形態は、図９に示すように、モータパルスがアップカウント入力とされ、リセットされない分周回路９１の出力（基準信号：１０Ｈｚ）がダウンカウント入力とされたアップダウンカウンタ９２を備えている。このアップダウンカウンタ９２により、発電機２０の起動時からのモータパルスと、分周回路９１の出力とを計数して比較することで、基準信号に対するモータパルスの累積誤差をカウントしている。

【００５７】このアップダウンカウンタ９２には、通常はＨレベル信号を出力し、前記カウンタ値が一定範囲を越えた場合、つまり累積誤差が大きくなった際にＬレベル信号を出力する累積誤差検出出力と、前記累積誤差がモータパルスの進み方向であればブレーキをＯＮする信号（Ｌレベル信号）を出力し、遅れ方向であればブレーキをＯＦＦする信号（Ｈレベル信号）を出力する進み／遅れ出力とが設けられている。尚、進み／遅れ出力は、累積誤差検出出力がＨレベルの期間は、Ｌレベルに保たれている。

【００５８】前記累積誤差検出出力は、フリップフロップ６４の出力４ＱとともにＡＮＤゲート９３に入力され、このＡＮＤゲート９３の出力は前記進み／遅れ出力とともにＯＲゲート９４に入力されている。

【００５９】このような本実施形態では、発電機２０の起動と同時に、アップダウンカウンタ９２によりモータパルスと分周回路９１の基準信号とがカウントされる。アップダウンカウンタ９２のカウント値が設定値内、つまりモータパルスの計数値と基準信号の計数値との差が一定範囲内におさまっている場合には、前記第１実施形態と同様に、フリップフロップ６４の出力４Ｑに基づいてブレーキ制御が行われる。

【００６０】一方、例えば、発電機２０が速く回転しており、モータパルスの計数値が基準信号の計数値よりも大きくなり、その差が設定値以上になると、累積誤差検出出力がＬレベルとなる。このため、フリップフロップ６４の出力４Ｑにマスクがかかり、ＡＮＤゲート９３の出力は常にＬレベルになり、出力４Ｑはキャンセルされる。

【００６１】このため、ブレーキ回路２３には、進み／遅れ出力の信号が出力され、これにより累積誤差を無くすようにブレーキが制御される。すなわち、モータパルスの計数値が基準信号の計数値よりも大きい場合には、Ｌレベル信号が出力されてブレーキは強制的にＯＮされ、モータパルスの計数値が基準信号の計数値よりも小さい場合には、Ｈレベル信号が出力されてブレーキは強制的にＯＦＦされる。

【００６２】このような本実施形態によれば、前記第１実施形態の①～④と同じ効果が得られる上、次の効果もある。

【００６３】⑥アップダウンカウンタ９２を設けているので、基準信号に対するモータパルスの進み／遅れの累積誤差をカウントすることができ、累積誤差が設定値以上に大きくなった場合には、その累積誤差を無くすようにブレーキ制御を行うことができ、このため、累積誤差が生じている際に迅速に正常制御に戻すことができ、調速制御の応答性をより一層高めることができる。

【００６４】なお、本発明は前記各実施形態に限定されるものではなく、本発明の目的を達成できる範囲での変形、改良等は、本発明に含まれるものである。

【００６５】例えば、前記第３実施形態において、ＯＲゲート９４の出力側に第２実施形態のチョッパリング回路８０を設けて、第３実施形態においてもチョッパリング制御を行えるようにしてもよい。

【００６６】また、速度比較回路５４やブレーキ制御回路５６の具体的構成は、前記各実施形態に限らず、例えばＮｃｈのトランジスタ２３Ｂを用いた場合など、ブレーキ回路２３の構成等に応じて適宜設定すればよい。また、カウンタリセットパルス７０の発生させる分周回路５２Ａの出力は、１６ｋＨｚのパルス信号に限らず、ロータ１２の回転周期等に合わせて適宜設定すればよい。

【００６７】さらに、ロータの回転検出信号と基準信号との周期の比較を行う手段は、前記各実施形態のものに限らず、構成に応じて適宜設定すればよい。

【００６８】

【発明の効果】以上に述べたように、本発明の電子制御式機械時計によれば、調速制御の応答性が速く、かつコストも低減できる。

【図面の簡単な説明】

【図１】本発明の第１実施形態における電子制御式機械時計の要部を示す平面図である。

【図２】図１の要部を示す断面図である。

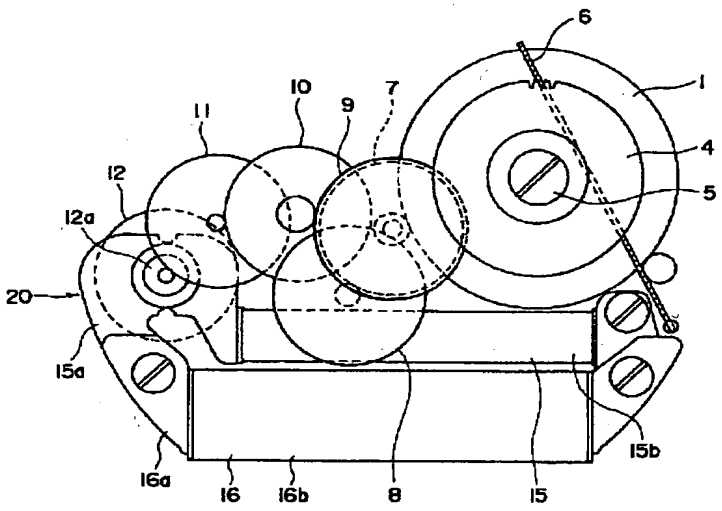
【図３】図１の要部を示す断面図である。

【図４】本実施形態の構成を示すブロック図である。

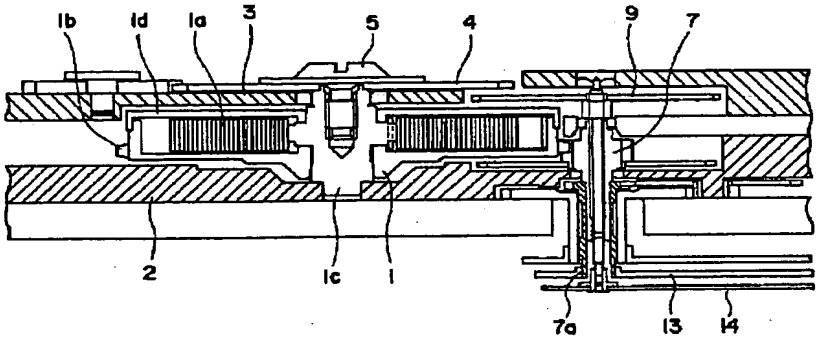
【図５】本実施形態の回転制御手段の構成を示す回路図である。

【図６】本実施形態の回路におけるタイミングチャートである。
【図７】本発明の第２実施形態の構成を示す回路図である。
【図８】第２実施形態の回路におけるタイミングチャートである。
【図９】本発明の第３実施形態の構成を示す回路図である。
【図１０】第３実施形態の回路におけるタイミングチャートである。
【符号の説明】
１　香箱車
１ａ　ゼンマイ
３　輪列受
７　二番車
８　三番車
９　四番車
１０　五番車
１１　六番車
１２　ロータ
１３　分針
１４　秒針
１５　ステータ
１６　コイルブロック
２０　発電機
２１　整流回路
２２　負荷
２３　ブレーキ回路
２３Ａ　制動抵抗
２３Ｂ　トランジスタ
５０　回転制御手段
５１　発振回路
５１Ａ　水晶振動子
５２，９１，５２Ａ，５２Ｂ　分周回路
５３　回転検出回路
５４　速度比較回路
５６　ブレーキ制御回路
６１～６４　フリップフロップ
７０　カウンタリセットパルス
８０　チョッパリング回路
８２　チョッパパルス発生回路
９２　アップダウンカウンタ

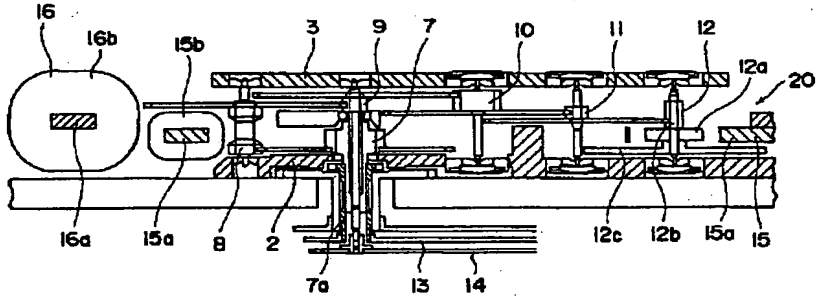
【図１】



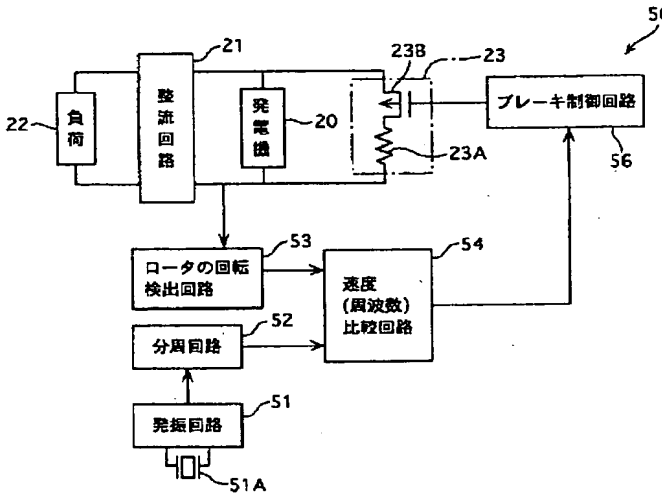
【図２】


1b
1d
1a
3
5
4
9
7
2
1c
1
7a
13
14

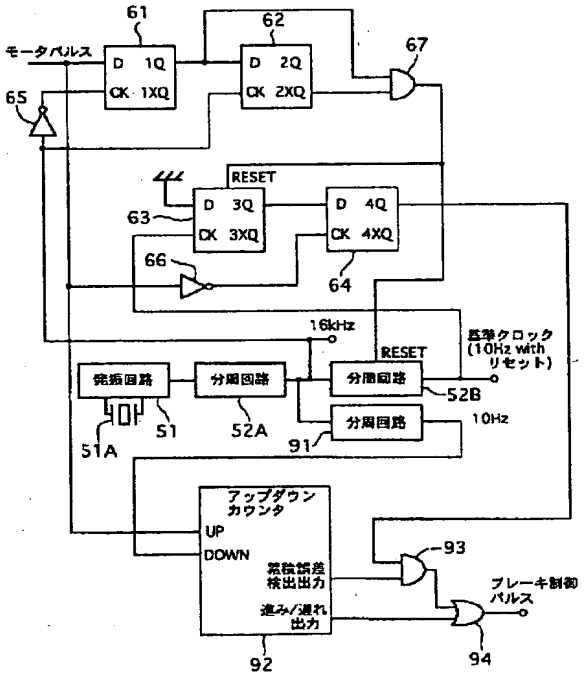
【図３】


16
16b
15b
3
9
7
10
11
12
12a
20
16a
15a
8
2
7a
13
14
12c
12b
15a
15

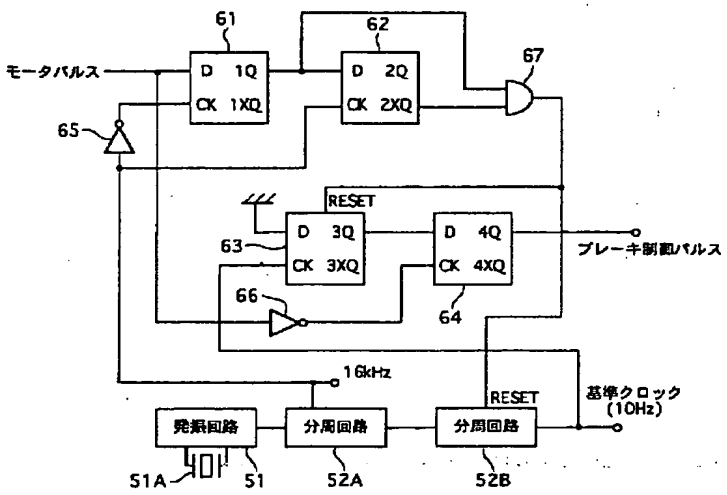
【図４】


50
21
23B
23
22
負荷
整流回路
発電機
20
23A
ブレーキ制御回路
56
ロータの回転検出回路
53
54
速度(周波数)比較回路
分周回路
52
発振回路
51
51A

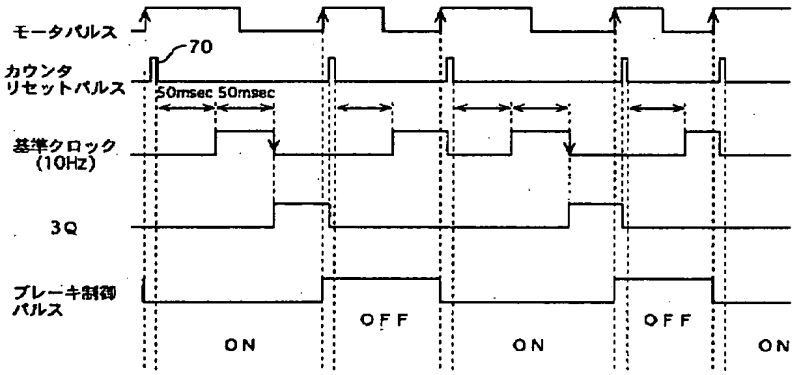
【図９】


61
62
モータパルス
D 1Q
CK 1XQ
D 2Q
CK 2XQ
67
65
RESET
D 3Q
CK 3XQ
D 4Q
CK 4XQ
63
66
64
16kHz
基準クロック(10Hz with リセット)
RESET
発振回路
分周回路
分周回路
52B
51A
51
52A
10Hz
91
アップダウンカウンタ
UP
DOWN
累積誤差検出出力
進み/遅れ出力
93
ブレーキ制御パルス
92
94

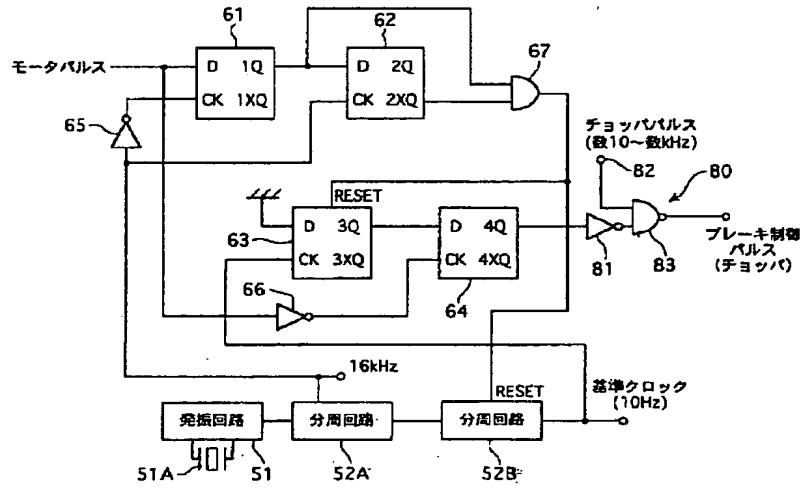
【図５】


61
62
67
モータパルス
D 1Q
CK 1XQ
D 2Q
CK 2XQ
65
RESET
63
D 3Q
CK 3XQ
D 4Q
CK 4XQ
ブレーキ制御パルス
66
64
16kHz
RESET
基準クロック
(10Hz)
発振回路
分周回路
分周回路
51A
51
52A
52B

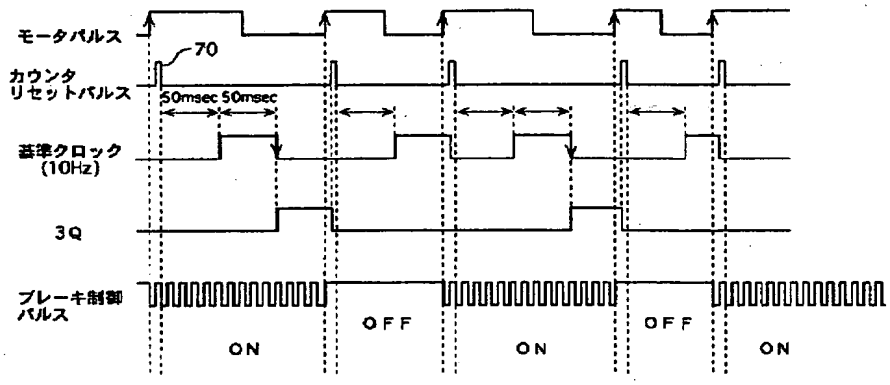
【図６】


モータパルス
70
カウンタ
リセットパルス
50msec 50msec
基準クロック
(10Hz)
3Q
ブレーキ制御
パルス
ON
OFF
ON
OFF
ON

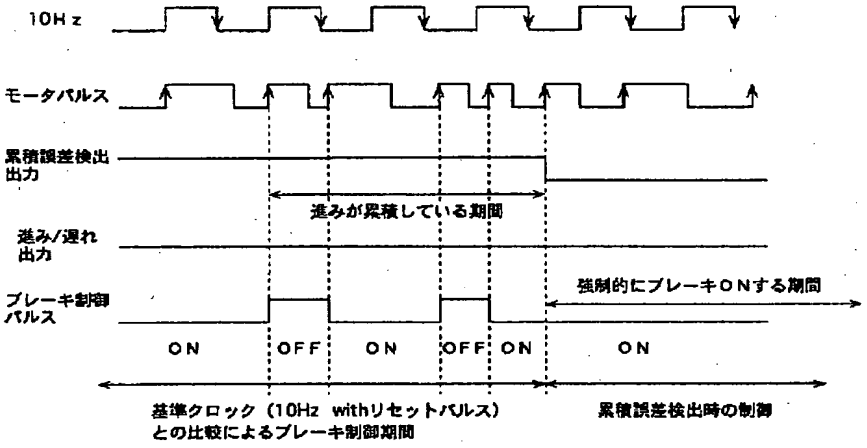
【図７】


61
62
67
モータパルス
D 1Q
CK 1XQ
D 2Q
CK 2XQ
65
チョッパパルス
(数10～数kHz)
82
80
RESET
D 3Q
CK 3XQ
D 4Q
CK 4XQ
63
ブレーキ制御
パルス
(チョッパ)
81
83
66
64
16kHz
RESET
基準クロック
(10Hz)
発振回路
分周回路
分周回路
51A
51
52A
52B

【図８】


モータパルス
70
カウンタ
リセットパルス
50msec 50msec
基準クロック
(10Hz)
3Q
ブレーキ制御
パルス
ON
OFF
ON
OFF
ON

【図１０】


10Hz
モータパルス
累積誤差検出
出力
進みが累積している期間
進み/遅れ
出力
ブレーキ制御
パルス
強制的にブレーキONする期間
ON
OFF
ON
OFF
ON
ON
基準クロック（10Hz withリセットパルス）
との比較によるブレーキ制御期間
累積誤差検出時の制御